



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 3681-3686
© 2022 TPI

www.thepharmajournal.com

Received: 15-04-2022

Accepted: 19-06-2022

G Shobhitha Rani

Department of Seed Science and Technology, TNAU, Coimbatore, Tamil Nadu, India

R Jerlin

Department of Seed Science and Technology, TNAU, Coimbatore, Tamil Nadu, India

K Raja

Department of Nanoscience, TNAU, Coimbatore, Tamil Nadu, India

MR Srinivasan

Department of Entomology, TNAU, Coimbatore, Tamil Nadu, India

Herbal molecules infused nano-fibre seed coating for extending shelf-life of black gram seeds

G Shobhitha Rani, R Jerlin, K Raja and MR Srinivasan

Abstract

A study on herbal molecules infused nano-fibre seed coating for extending the storability of accelerated aged black gram seeds at the Department of Seed Science and Technology, TNAU, Coimbatore was undertaken during 2022. The nano-fibre developed from zein (20%) was infused with curcumin and azadirachtin. Zein nano-fibre matrix was applied to genetically pure black gram cv.VBN 8 seeds at various concentrations viz., 5, 10, 15, 20, 25, 30, 35, 40, and 45 ml per kg of seeds. The treated seedlings underwent 10 days of accelerated aging at temperature 40 °C and relative humidity of 98±2%. The seed samples of 50-100g were taken each day during the accelerated aging process and analyzed for physiological parameters. In terms of germination (77 percent), root (14.3 cm) and shoot length (15.3 cm), and seedling vigour index I (2202) and II (22), the seeds revitalized with zein nanofiber matrix at 20 ml per kg of seeds considerably outperformed the control seeds. The results of this study revealed that, despite the accelerated aging process, black gram seeds infused with zein nanofiber matrix at 20 ml per kg of seeds outperformed other treatments.

Keywords: Zein, curcumin, azadirachtin, black gram, VBN 8, accelerated aging

Introduction

Black gram (*Vigna mungo* L.), which ranks third among the pulses which contain about 26% protein. This is about three times as much protein as cereal developed in India. The poor performance of black gram may be attributed to several factors, in which level of seed deterioration is of great importance. Using the seed lot with reduced vigour and viability for sowing may affect the field performance and productivity of the resultant crops (Layek *et al.*, 2007; Pati and Bhattacharjee, 2011) [9, 12]. Therefore, there is a need to improve the performance of deteriorated seeds which is possible through seed treatments. The seed polymer coating is the most promising of the many novel production methods among the different “seed enhancement techniques” that have been developed by numerous scientists worldwide. The complex technique of applying a precise amount of active chemicals, and a liquid polymer on the surface of the seed without impairing its structure is known as a seed polymer coating which is one of the most cost-effective methods for enhancing the performance of seeds. It also makes room for adding all necessary components, such as nutrient sources, herbicides, hydrophilic compounds, inoculants, protectants, nutrients, oxygen supplies, etc. This article outlines a simple method for extending shelf life by coating seeds with electro-spun zein nano-fibres containing curcumin and azadirachtin. Zein is the preferred polymer because of its excellent electrospinning properties, low water solubility, and eventual biodegradability. Nanofibrous coatings are immediately electro-spun onto black gram seeds, and regardless of coating thickness and homogeneity, they have no detrimental impacts on seed germination. Zein is a storage protein derived from corn that is proline-rich, water-insoluble, yet alcohol-soluble. Zein is the prolamin in corn and is an abundant biopolymer in corn gluten meal, which is a co-product of corn wet milling (Shukla and Cheryan, 2001; Lawton, 2002) [14]. Zein possesses the benefits of being renewable and biodegradable (Shukla and Cheryan, 2001) [14]. The production of zein nanofibers by electrospinning was reported previously (Neo *et al.*, 2012; Karthikeyan *et al.*, 2012) [16, 8]. The rhizome of turmeric contains curcumin, a naturally occurring polyphenol that acts as an herbal antioxidant. The neem seed extract azadirachtin functions as a biopesticide. In addition to acting as a protective layer to prolong the shelf life of seeds under aging, the zein protein serves as a transporter for the bioactive compounds. Similar to this, the bio-pesticide chemical azadirachtin functions as an antifeedant that affects chemoreceptors in addition to lowering the production of the ecdysone hormone, which kills insect larvae. Studies on water dissolution reveal that nano-fibres retain

Corresponding Author:

G Shobhitha Rani

Department of Seed Science and Technology, TNAU, Coimbatore, Tamil Nadu, India

their integrity for over two weeks, which is a need for the success of this strategy. Curcumin and azadirachtin are slowly and consistently released from the nano-fibres. Considering this, the article is proposed how herbal molecule-based zein nano-fibre is used for extending the shelf life of pulses through accelerated aging.

Materials and Methods

Genetically and physically pure black gram seeds var. VBN 8 was purchased from the Department of pulses, TNAU, Coimbatore. High purity biopolymer zein, curcumin (97% purity), and azadirachtin were purchased from M/s Sigma Aldrich, Private Limited, Bangalore, India.

Synthesis of zein nano-fibre matrix infused with herbal molecules

For synthesizing herbal molecules infused with zein nano-fibre the optimized dose for curcumin, azadirachtin and zein were taken, and the nanofiber matrix system was prepared.

Preparation of Zein nano-fibre matrix

By adding 10ppm of azadirachtin and 80ppm of curcumin, a zein nano-fibre matrix was created. 2ml of 100ppm curcumin from stock solution B was added dropwise while being continuously stirred at 300rpm using a magnetic stirrer to 24 ml of 20% zein from stock solution A in a 250 mL beaker to prepare 100 mL of nano-fibre matrix. Next, drop by drop, 0.2mL of 100ppm azadirachtin from stock solution C was added.

Seed coating with zein nano-fibre matrix

Seeds of black gram (VBN 8) were coated with zein nano-fibre matrix at different concentrations viz., 5,10,15,20,25,30,35,40,45 millilitre per kg. Seed coating was done using a vertical electrospinning unit. The treated seeds were subjected to accelerated aging for 10 days as per the procedure described by Delouche and Baskin (1973), where the temperature in the accelerated aging chamber was maintained at 40°C with a relative humidity of 98±2%. Every day of accelerated aging, the required quantity (50-100g) of seed samples was drawn and tested for physiological and biochemical seed quality attributes.

Germination: The germination test was carried out using 4 × 100 seeds in a paper medium (ISTA, 2016). The test conditions of 25 ± 2°C temperature and 95 ± 3% relative humidity were maintained in the germination room. At the end of seven days, normal seedlings were counted and the mean was expressed as a percentage.

Shoot and root length: Shoot and root length of normal seedlings that are randomly selected from each replication of the germination test were measured and the mean was expressed in centimetre.

Dry matter production: The seedlings used for growth measurement were shade dried for 24 h (after removing the cotyledons and seed coat) and dried again in a hot air oven maintained at 85 ± 2°C for 24 h and cooled in desiccators filled with silica gel for 30 min. The dry weight of seedlings was recorded using an electronic balance and expressed as g 10 seedlings⁻¹.

Vigour index I & II: Vigour index I &II values were computed using the following formula as suggested by Abdul Baki and Anderson (1973) and the mean values were expressed in the whole numbers.

Vigour index I = Germination (%) x Total seedling length (cm)

Vigour index II = Germination (%) x Dry matter production (g / 10 seedlings)

Statistical analysis: The experiment data were analysed statistically using analysis of variance (ANOVA) as a factorial combination of treatments. The values in percent data were arcsine converted before analysis. The critical differences (CD) were computed at a 5 percent probability level (Panse and Sukhatme, 1984) [11]

Results and Discussion

Seed deterioration is an inevitable process that reduces the seed viability and vigour, making it difficult to supply quality seeds to the farmers at right time. Seed invigoration techniques like seed priming with chemicals, pesticides, botanicals, halogenations, hydration and dehydration (H-D), dry permeation, soaking drying (S-D), etc., are used to reduce seed deterioration (Thirusenduraselvi D and Jerlin R 2010; Duraimurugan *et al.*, 2011) [15, 5]. Coventry *et al.* (2001) concluded that azadirachtin possesses high insecticidal activity and antimicrobial activity. Assis *et al.* (2009) [2] observed that zein is a natural maize protein that is highly hydrophobic be used as a seed coating agent and a carrier for biomolecules. Zein is known to delay moisture absorption and delays germination. Bhardwaj and Kundu (2010) [3] reported electrospinning as fascinating fibre fabrication technique. Sakthivel (2004) [13] reported that this process of abiotic seed deterioration can be reduced by the use of antioxidants. Seeds coated with turmeric rhizome powder at the rate of 10 grams per kg extended the storability of black gram.

The idea of this research was to create a zein nano-fibre matrix-based seed invigoration method that was both economically and environmentally viable. Black gram cv. VBN 8 seeds were coated with nano-fibre matrix at various concentrations, i.e., 5, 10, 15, 20, 25, 30, 35, 40, and 45 ml per kg of seeds and then exposed to accelerated aging. The accelerated aged seeds were then assessed for physiological quality parameters. Among the different treatments T4(77%) recorded maximum germination irrespective of the accelerated duration. The period of accelerated ageing increases and germination per cent decreases, irrespective of treatments (Table 1). Among the different treatments T4 (14.3 cm) recorded maximum root length, irrespective of the accelerated duration. The period of accelerated ageing increases, root length decreases irrespective of treatments (Table 2). Among the different treatments T4 (15.3 cm) recorded maximum shoot length, irrespective of the accelerated aging duration. The period of accelerated ageing increases and shoot length decreases, irrespective of treatments (Table 3). Among the different treatments T4 (0.284 g/10 seedlings) recorded maximum dry matter production, irrespective of the accelerated duration. The period of accelerated aging increases, dry matter production decreases irrespective of treatments (Table 4). Among the different treatments T4 (2202) recorded maximum vigour

index I irrespective of the accelerated duration. The period of accelerated ageing increases and vigour index I decreases irrespective of treatments (Table 5). Among the different treatments T4 (22) recorded maximum vigour index II irrespective of the accelerated duration. The period of accelerated ageing increases, vigour index II decreases irrespective of treatments (Table 6). Effect of herbal molecules infused zein nano-fibre seed coating on germination (%) and vigour index of black gram cv.VBN 8 under accelerated aging condition shown in (Fig 1). The results showed that the invigorated seeds with zein nano-fibre matrix at 20 ml per kg of seeds significantly registered higher germination (77) and seedling vigour index I (2202) and vigour index II (22), as compared to the control, which

recorded the minimum germination of 58%, root (10.3cm) and shoot (14.9cm) length, vigor index I (1536) percent, and II (12). The overall findings of this investigation suggest regardless of the extended aging period, black gram seeds infused with zein nano-fibre matrix at a rate of 20 ml per black gram outperformed the other treatments.

Due to the antioxidant characteristics of curcumin and bio-pesticide properties of azadirachtin which it possesses, the zein nano-fibre matrix seed invigoration outperforms other seed invigorations in preventing seed deterioration throughout accelerated aging by contributing unpaired free electrons that are coupled with free ones decreasing the generation of free radicals.

Table 1: Effect of herbal molecules infused zein nano-fibre seed coating on germination (%) of black gram cv. VBN 8 under the accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D0	D1	D 2	D 3	D 4	D 5	D 6	D 7	D 8	D9	D 10	
T ₀	94	92	89	87	84	79	74	70	67	63	60	78
T ₁	95	93	91	89	87	84	81	78	75	72	71	83
T ₂	95	93	91	91	88	86	82	79	76	73	72	84
T ₃	96	94	92	92	90	87	83	80	77	75	73	85
T ₄	96	96	95	94	93	90	87	84	81	79	77	88
T ₅	95	95	93	92	91	88	85	82	79	76	74	86
T ₆	94	93	93	92	91	87	84	82	78	77	75	86
T ₇	94	93	92	92	89	86	83	81	76	75	73	85
T ₈	93	92	92	91	87	85	83	80	75	74	72	84
T ₉	93	92	90	88	86	84	81	77	74	72	68	82
Mean	95	93	92	91	89	86	82	79	76	74	72	84
	Treatment (T)				Duration (D)				TXD			
SEd	0.532				0.659				2.217			
CD (P=0.05)	1.242				1.257				3.624			

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

Table 2: Effect of herbal molecules infused zein nano-fibre seed coating root length (cm) of black gram cv. VBN 8 under accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇	D ₈	D ₉	D ₁₀	
T ₀	19.4	19.1	18.5	18.2	17.2	16.6	15.4	14.8	14.0	13.0	12.1	16.2
T ₁	20.0	19.6	19.6	18.9	18.6	17.9	17.2	15.8	15.3	14.0	13.1	17.3
T ₂	20.1	20.0	19.5	19.3	18.5	18.3	17.2	16.2	15.2	14.3	13.1	17.4
T ₃	20.4	19.9	19.9	19.2	18.8	18.3	17.6	16.3	15.6	14.4	13.6	17.6
T ₄	20.9	20.3	20.3	19.7	19.3	18.6	18	16.7	16.1	14.8	14.3	17.8
T ₅	20.5	20.3	19.8	19.6	18.8	18.5	17.5	16.6	15.7	14.7	13.7	18.1
T ₆	20.4	20.2	19.7	19.7	18.9	18.5	17.4	16.5	15.5	14.6	13.6	17.8
T ₇	20.2	19.7	19.6	19.4	18.8	18.1	17.3	16.3	15.4	14.2	13.5	17.6
T ₈	19.7	19.8	19.4	19.4	18.3	18.0	16.9	16.3	15.0	14.1	13.3	17.3
T ₉	19.6	19.7	19.6	19.3	18.4	18.1	16.8	16.0	14.8	14.0	13.2	17.5
Mean	20.1	19.9	19.7	19.3	18.6	18.1	17.1	16.2	15.3	14.2	13.4	17.5
	Treatment(T)				Duration(D)				TXD			
SEd	0.162				0.194				0.521			
CD (P=0.05)	0.356				0.398				0.916			

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

Table 3: Effect of herbal molecules infused zein nano-fibre seed coating shoot length (cm) of black gram cv. VBN 8 under accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇	D ₈	D ₉	D ₁₀	
T ₀	21.3	20.9	20.3	19.9	18.9	18.5	17.1	16.4	15.4	14.6	13.5	17.9
T ₁	21.9	21.4	21.2	20.7	20.4	19.6	19	17.9	17.2	15.8	14.6	19.1
T ₂	22	21.8	21.2	21	20.4	20	18.9	18.3	17.2	16.4	14.5	19.2
T ₃	22.7	21.9	21.9	21.1	20.8	19.9	19.3	18.3	17.7	16.4	14.9	19.5
T ₄	23.1	22.7	22.4	21.8	21.3	20.5	19.8	18.7	18	16.8	15.3	20.0
T ₅	22.7	22.4	21.8	21.7	21	20.4	19.4	18.6	17.6	16.6	14.9	19.7
T ₆	22.8	22.6	21.9	21.6	20.9	20.4	19.3	18.6	17.5	16.6	14.8	19.7
T ₇	22.6	22	21.8	21	20.7	19.9	19.3	18.2	17.4	16.1	14.7	19.4
T ₈	22	21.8	21.3	20.6	20.1	19.7	18.9	18.2	16.9	16.1	14.1	19.1
T ₉	22	21.6	21.2	20.4	20	19.6	18.6	18	16.6	16	13.9	19.3
Mean	22	22	21	21	20	20	19	18	17	16	15	19
	Treatment(T)				Duration(D)				TXD			
SEd	0.152				0.183				0.460			
CD (P=0.05)	0.402				0.412				0.734			

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

Table 4: Effect of herbal molecules infused zein nano-fibre seed coating on dry matter production (g/10 seedlings) of black gram cv. VBN 8 under accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇	D ₈	D ₉	D ₁₀	
T ₀	0.397	0.384	0.361	0.342	0.335	0.327	0.302	0.286	0.267	0.248	0.217	0.3150
T ₁	0.406	0.401	0.399	0.384	0.372	0.364	0.354	0.325	0.314	0.296	0.264	0.3526
T ₂	0.405	0.404	0.403	0.387	0.375	0.362	0.352	0.327	0.318	0.295	0.266	0.3540
T ₃	0.405	0.403	0.402	0.389	0.378	0.364	0.357	0.332	0.326	0.292	0.278	0.3569
T ₄	0.415	0.411	0.41	0.408	0.396	0.385	0.378	0.368	0.357	0.326	0.284	0.3761
T ₅	0.408	0.406	0.405	0.403	0.392	0.381	0.364	0.352	0.348	0.318	0.276	0.3684
T ₆	0.41	0.408	0.407	0.405	0.39	0.376	0.362	0.35	0.345	0.315	0.282	0.3681
T ₇	0.406	0.404	0.403	0.402	0.386	0.372	0.36	0.347	0.338	0.312	0.273	0.3639
T ₈	0.405	0.403	0.402	0.399	0.384	0.368	0.357	0.343	0.335	0.286	0.268	0.3590
T ₉	0.404	0.402	0.401	0.387	0.372	0.364	0.352	0.334	0.326	0.291	0.26	0.3539
Mean	0.4061	0.4026	0.3993	0.3906	0.378	0.3663	0.3538	0.3364	0.3274	0.2979	0.2668	0.3568
	Treatment(T)				Duration(D)				TXD			
SEd	0.003				0.003				0.008			
CD (P=0.05)	0.005				0.005				0.019			

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

Table 5: Effect of herbal molecules infused zein nano fibre seed coating on vigour index-I of black gram cv. VBN 8 under accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇	D ₈	D ₉	D ₁₀	
T ₀	3826	3680	3453	3315	3032	2773	2405	2184	1970	1739	1536	2719
T ₁	3981	3813	3713	3569	3393	3150	2932	2629	2438	2146	1967	3066
T ₂	4000	3887	3704	3667	3423	3294	2960	2726	2462	2241	1987	3123
T ₃	4128	3929	3827	3708	3564	3323	3063	2768	2564	2310	2081	3206
T ₄	4180	4099	3971	3873	3695	3510	3213	2957	2705	2489	2202	3350
T ₅	4147	4076	3962	3818	3692	3432	3210	2895	2694	2386	2190	3323
T ₆	4061	3980	3887	3800	3622	3384	3083	2895	2574	2402	2145	3258
T ₇	4023	3878	3836	3717	3516	3268	3038	2795	2493	2273	2081	3174
T ₈	3878	3827	3744	3640	3341	3205	2971	2760	2393	2235	1973	3088
T ₉	3869	3800	3672	3494	3302	3167	2867	2618	2324	2160	1843	3010
Mean	4009	3897	3777	3660	3458	3251	2974	2722	2462	2238	2000	3132
	Treatment(T)				Duration(D)				TXD			

SEd	23.104	27.841	80.241
CD (P=0.05)	41.528	53.426	149.286

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

Table 6: Effect of herbal molecules infused zein nano-fibre seed coating on vigour index II of black gram cv. VBN 8 under accelerated aging condition

Treatments (T)	Accelerated aging duration in days(D)											Mean
	D ₀	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆	D ₇	D ₈	D ₉	D ₁₀	
T ₀	37	35	32	30	28	26	22	20	18	16	13	25
T ₁	39	37	36	34	32	31	29	25	24	21	19	30
T ₂	38	37	37	35	33	31	29	26	24	22	19	30
T ₃	39	38	37	36	34	32	30	27	25	22	20	31
T ₄	40	39	39	38	37	35	33	31	29	26	22	33
T ₅	39	38	38	37	36	34	31	29	27	24	20	32
T ₆	38	38	38	37	36	33	30	29	27	24	21	32
T ₇	38	37	37	37	34	32	30	28	26	23	20	31
T ₈	38	37	37	36	33	31	30	27	25	21	19	30
T ₉	37	37	36	34	32	31	29	26	24	21	18	29
Mean	38	37	37	35	34	32	29	27	25	22	19	30
	Treatment(T)				Duration(D)				TXD			
SEd	0.326				0.401				1.128			
CD (P=0.05)	0.612				0.618				1.820			

T ₀ - control	T ₄ -20ml/kg zein nano-fibre matrix coated seeds	T ₈ -40ml/kg zein nano-fibre matrix coated seeds
T ₁ -5ml/kg zein nano-fibre matrix coated seeds	T ₅ -25ml/kg zein nano-fibre matrix coated seeds	T ₉ -45ml/kg zein nano-fibre matrix coated seeds
T ₂ -10ml/kg zein nano-fibre matrix coated seeds	T ₆ -30ml/kg zein nano-fibre matrix coated seeds	D-Days of accelerated ageing
T ₃ -15ml/kg zein nano-fibre matrix coated seeds	T ₇ -35ml/kg zein nano-fibre matrix coated seeds	

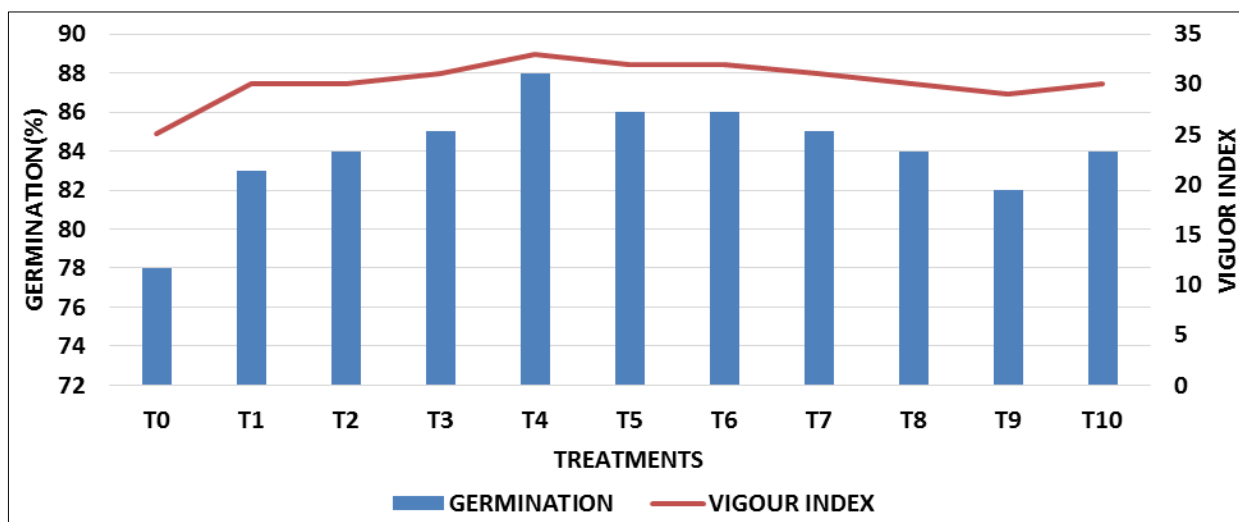


Fig 1: Effect of herbal molecules infused zein nano-fibre seed coating on germination (%) and vigour index of black gram cv. VBN 8 under accelerated aging condition

Conclusion

The curcumin, azadirachtin and zein polymer coated seeds with the concentration of 20 ml per kg have enhanced physiological quality viz., germination per cent, seedling length, dry matter production and vigour index. Therefore, the herbal compounds may be successfully infused into the zein nano-fibre matrix, which can then be employed as a successful seed invigoration material to prolong the viability of black gram seeds under aging. This early finding requires more investigation. Additionally, this should be tested on a big scale and contrasted with the results of in-depth studies before reaching the end customers, traditional methods were

used. The study clearly evidenced the successful encapsulation of herbal molecules in electro-spun nano-fibre for extended shelf-life of black gram seeds.

References

1. Abdul-Baki AA, Anderson JD. Vigor determination in soybean seed by multiple criteria 1. Crop science. 1973;13(6):630-633.
2. Assis OBG, Leoni AM. Protein hydrophobic dressing on seeds aiming at the delay of undesirable germination. Scientia Agricola. 2009;66:123-126.
3. Bhardwaj N, Kundu SC. Electrospinning: A Fascinating

- Fiber Fabrication Technique. *Biotechnol. Adv.* 2010;28(3):325–347.
4. Coventry E, Allan EJ. Microbiological and chemical analysis of neem (*Azadirachta indica*) extracts: new data on antimicrobial activity. *Phytoparasitica.* 2001;29(5):441-450.
 5. Duraimurugan P, Raja K, Regupathy A. An eco-friendly approach for management of pulse beetle, *Callosobruchus maculatus* through neem formulations assisted with pitfall trap. *Journal of Food Legumes* 2011;24(1):23-27.
 6. Islam AA, Delouche JC, Baskin CC. Comparison of methods for evaluating deterioration in rice seed. In *Proceedings of the Association of Official Seed Analysts* 1973, 155-160.
 7. ISTA. *International Rules for Seed Testing.* In *The International Seed Testing Association*, edited by Switzerland Bassersdorf, 2016.
 8. Karthikeyan K, Rachita L, Rama R, Purna KS. Development and characterization of zein-based microcarrier system for sustained delivery of aceclofenac sodium. *AAPS Pharm Sci Tech.* 2012;13:143–149.
 9. Layek N, De BK, Mishra SK, Mandal AK. Seed invigoration treatments for improved germinability and field performance of gram (*Cicer arietinum* L.). *Legume Res.* 2007;29(4):257-261.
 10. Lawton Zein JW: A history of processing and use. *Cereal Chem.* 2002;79:1-18.
 11. Panse V, Sukhatme P. *Statistical methods for Agricultural workers.* III Rev. Ed. ICAR, New Delhi, 1995.
 12. Pati Bhattacharjee CK. A Sunflower seed invigoration by chemical manipulation. *Afr. J Plant Sci.* 2011;5(15):867-872
 13. Sakthivel N, Qadri S, Krishnamoorthy T. A new technique for commercial eri silkworm (*Samia ricini* Bois.) Seed production. *Proceedings, National workshop on Potential and strategies for sustainable development of vanya silk in the Himalayan States, Dehradun, 2004.*
 14. Shukla R, Cheryan M, DeVcr RE. Solvent extraction of zein from dry-milled corn. *Cereal Chem.* 2000;77:724-730.
 15. Thirusenduraselvi D, Jerlin R. Effect of pre-germination treatments on the emergence percentage of bitter gourd cv. CO 1 seeds. *Tropical Agricultural Research and Extension.* 2010;10:88-89.
 16. Neo YP, Ray S, Easteal AJ. Influence of solution and processing parameters towards the fabrication of electrospun zein fibers with sub-micron diameter *Journal of Food Engineering,* 2012.